

Amendments to the Claims:

The listing of claims will replace all prior versions, and listings of claims in the application:

Listing of Claims:

Claim 1 (original) In the method of detecting a localized sun gear fault, in the operation of an epicyclic gear train having ring, planet and sun gears, and a planet carrier, the steps that include

- a) detecting sun gear vibrations transmitted through each planet gear,
- b) computing separated averages of such detected vibrations,
- c) phase shifting said averages to account for the differences in gear meshing positions,
- d) and re-combining said phase shifted averages to produce a modified average value of the sun gear vibration.

Claim 2 (original) The method of claim 1 wherein a detection transducer is provided and operated on the ring gear.

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Claim 3 (original) The method of claim 1 wherein one separated average is selected as a reference, and the remaining averages are phase shifted by the angle between its planet and the reference planet so that the beginning of each separated average starts with the same sun gear tooth in mesh with each planet, and all the separated averages are aligned.

Claim 4 (original) The method of claim 3 wherein a detection transducer is provided and operated on the ring gear.

Claim 5 (original) The method of claim 2 wherein the sun gear vibration is transmitted to the transducer through the individual planet gears, and the expected sun gear vibration signal detected by the transducer is the sum of the sun gear vibration with each planet multiplied by the individual planet pass modulations.

Claim 6 (currently amended) The method of claim 5 wherein the expected sun gear vibration signal $x_s(t)$ is determined substantially in accordance with the following equation (6) represented as follows:

$$x_s(t) = \sum_{p=0}^{P-1} \alpha_p(t) v_{s,p}(t),$$

where: $\alpha_p(t)$ is the amplitude modulation due to planet p , and $v_{s,p}(t)$ is the tooth meshing vibration of the sun gear with planet $[[p.]]$ p , and P is the number of planets.

Claim 7 (currently amended) The method of claim 5 wherein the expected sun gear vibration signal $x_s(\theta)$ expressed in the angular domain is determined substantially in accordance with the following equation (7) represented as follows:

$$x_s(\theta) = \sum_{p=0}^{P-1} \alpha_p \left(\frac{N_s}{N_r} \theta \right) v_{s,p}(\theta),$$

where θ is the relative rotation of the sun with respect to the planet carrier $[[.]]$ P is the number of planets,

p = planet

N_s = the number of teeth on the sun gear,

N_r = the number of teeth on the ring gear,

$v_{s,p}(\theta)$ = the tooth meshing vibration of the
sun gear with planet P,
 $\alpha_p(N_s/N_r\theta)$ = the amplitude modulation due to
planet p.

Claim 8 (currently amended) The method of claim 4 wherein the amplitude modulation function (8) (planet-pass modulation), ~~$\alpha_p(\varphi)$~~ , ~~has the same form for all planets,~~ ~~differing~~ differs only by a phase delay, $2\pi p/P$,

$$\alpha_p(\varphi) = \alpha\left(\varphi - \frac{2\pi p}{P}\right),$$

where $\alpha(\varphi)$ is the planet-pass modulation function and

φ is the planet carrier angle

p is the planet $[[p]]$

P is the number of planets

Claim 9 (original) The method of claim 1 wherein steps a) and b) include providing and operating a filter proportionally dividing the overall vibration signal into estimated contributions from each planet gear.

Claim 10 (original) The method of claim 9 wherein separated sun gear values $\bar{z}_{s,p}(\theta)$ are derived.

Claim 11 (currently amended) The method of claim 10 wherein said value $z_{s,p}(\theta)$ taken over N periods of the relative sun gear rotation is represented substantially by the following equation (10):

$$\begin{aligned}\bar{z}_{s,p}(\theta) &= \frac{1}{N} \sum_{n=0}^{N-1} w\left(\frac{N_s}{N_r}(\theta + 2\pi n) - \frac{2\pi p}{P}\right) x_s(\theta + 2\pi n) \\ &= \frac{1}{N} \sum_{n=0}^{N-1} w\left(\frac{N_s}{N_r}(\theta + 2\pi n) - \frac{2\pi p}{P}\right) \left[\sum_{k=0}^{P-1} a\left(\frac{N_s}{N_r}(\theta + 2\pi n) - \frac{2\pi k}{P}\right) v_{s,k}(\theta + 2\pi n) \right] \\ &= \sum_{k=0}^{P-1} \bar{v}_{s,k}(\theta) \frac{1}{N} \sum_{n=0}^{N-1} w\left(\frac{N_s}{N_r}(\theta + 2\pi n) - \frac{2\pi p}{P}\right) a\left(\frac{N_s}{N_r}(\theta + 2\pi n) - \frac{2\pi k}{P}\right),\end{aligned}$$

where $v_{s,k}(\theta)$ is the mean vibration of the sun gear with planet k[[.]], θ is the relative rotation of the sun with respect to the planet carrier, $x_s(\theta)$ is the expected sun gear vibration signal, N_s is the number of teeth on the sun gear, N_r is the number of teeth on the ring gear, $w(N_s/N_r\theta)$ is the planet separation window function, $a(N_s/N_r\theta)$ is the planet-pass modulation function, $v_{s,k}(\theta)$ is the tooth meshing vibration of the sun gear with planet k, $\bar{v}_{s,k}(\theta)$ is the mean vibration of the sun gear with planet k, and P is the number of planets.

Claim 12 (currently amended) The method of claim 10 wherein a modified sun gear average value $z_{s,m}(\theta)$ is derived and represented substantially by the following equation

$$\bar{z}_{s,m}(\theta) = \sum_{p=0}^{P-1} \sum_{k=0}^{P-1} \bar{v}_{s,k} \left(\theta - \frac{2\pi p}{P} \right) \left[W_0 A_0 + 2 \sum_{l=1}^{P-1} W_l A_l \cos \left(l \left(k - p \right) \frac{2\pi}{P} \right) \right],$$

where the delay, $2\pi p/P$, aligns the mean sun gear vibration with each planet, $v_{s,k}(\theta)$, so that the beginning of each separated average starts with the same sun gear tooth in mesh with each planet[[.]], and θ is the relative rotation of the sun with respect to the planet carrier, p , k and l are summation indicies, P is the number of planets, W_0 and W_l are the Fourier coefficients of the planet separation window function, A_0 and A_l are the Fourier coefficients of the planet-pass modulation function.

Claim 13 (original amended) The method of claim 10 wherein a modified sun gear average value $Z_{s,m}(\theta)$ is derived and represented substantially by the following equation (20)

$$\begin{aligned}\bar{Z}_{s,m}(\theta) &= \bar{v}_s(\theta) \sum_{p=0}^{P-1} \sum_{k=0}^{P-1} \left[W_0 A_0 + 2 \sum_{l=1}^{P-1} W_l A_l \cos \left(l(k-p) \frac{2\pi}{P} \right) \right] \\ &= P W_0 A_0 \bar{v}_s(\theta),\end{aligned}$$

where $Z_{s,m}(\theta)$ is the mean vibration of the sun gear with a single planet gear, and θ is the relative rotation of the sun with respect to the planet carrier, p , k and l are summation indicies, P is the number of planets, W_0 and W_l are the Fourier coefficients of the planets separation window function, A_0 and A_l are the Fourier coefficients of the planet-pass modulation function, and $\bar{v}_s(\theta)$ is the mean vibration of the sun gear with a single planet.